Tokyo Tech Research Units

VCSEL Photonics Unit

Overview

The vertical cavity surface emitting laser (VCSEL), invented by Professor Emeritus Kenichi Iga of Tokyo Institute of Technology, has become a key component in "Internet-of-Things" applications such as fiber-optic communications, face recognition in mobile phones, and LiDAR for autonomous driving. At the VCSEL Photonics Unit, we develop core technologies for the next generation of information and communication technology, Beyond 5G. Ultra-high-speed high-capacity optical communications, high-resolution 3D sensing, and other technologies based on VCSEL photonics are expected to become the foundation of all industries and society by the 2030s. Forty-four years have passed since the invention of the VCSEL. We are working to promote further technological and social developments through VCSEL photonics.

Research Unit Leader **Fumio Koyama**

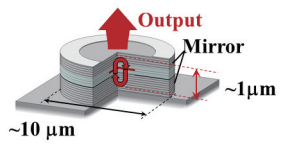
Profile

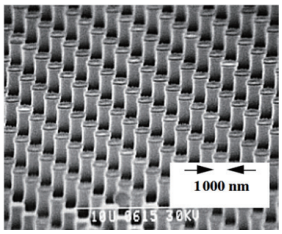
2020 Professor, Institute of Innovative Research, Tokyo Institute of Technology
2018 Director-General/Professor, Institute of Innovative Research, Tokyo Institute of Technology
2016 Director/Professor, FIRST, Tokyo Institute of Technology
2000 Professor, Precision and Intelligence Laboratory, Tokyo Institute of Technology
1988 Associate Professor, Precision and Intelligence Laboratory, Tokyo Institute of Technology
1985 Research Associate, Precision and Intelligence Laboratory, Tokyo Institute of Technology

Research Goals

Our research unit will pursue the following goals:
(1) Development of a next-generation edge cloud computing infrastructure that supports Beyond 5G ultra-high capacity wireless communications, particularly research on co-packaged optics and ultra-compact optical transceivers using VCSEL arrays.
(2) Development of ultra-high-speed, low-power consumption, low-cost VCSELs used for large-capacity front hall networks connecting wireless base stations, and ultra-high-speed single-mode optical fiber transmission technology.
(3) Development of the next generation in 3D sensing technology: LiDAR is a key sensing technology in autonomous driving systems that allows for scanning of the surroundings in 3D. We will develop a solid state, ultra-high resolution beam deflector without moving parts.

VCSELs and their Application Fields



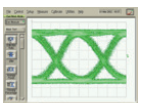


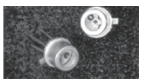
VCSEL and their 2D array


3D Camera


LiDAR


after FujiXerox





Sensing

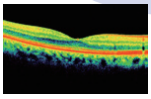
Datacom

Printing

VCSEL Photonics


after Princeton Optronics

High Power



Medical

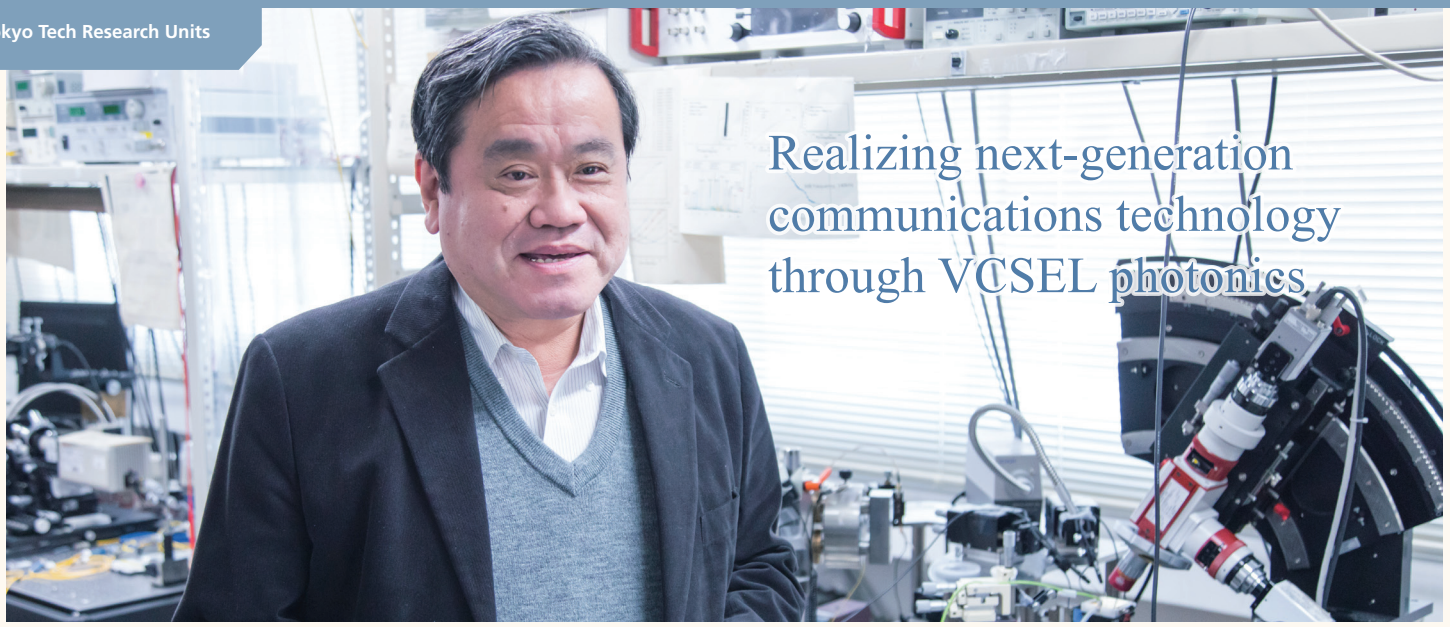
OCT image of retina
http://www.oct-optovue.com/

Interconnects


Data Center


DVI for 8K TV

Various Applications of VCSEL Photonics



Realizing next-generation communications technology through VCSEL photonics

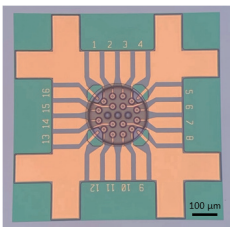
Q What are the strengths of this research unit?

Starting first with the realization of continuous room temperature operation of VCSELs, we have been working to improve the performance of VCSELs and create new functions. We have developed world-leading core technologies such as low-power consumption and high-speed VCSELs, as well as the world's highest resolution solid-state optical deflector. We are also promoting social implementation through joint research with industry, government, and academia in programs such as the NICT Beyond 5G R&D Promotion Project, NEDO Post 5G Information and Communication Systems Infrastructure Reinforcement R&D Project, and JST A-STEP industry-academia collaboration.

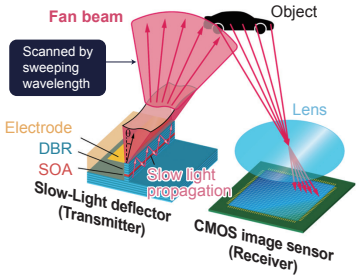
Q What is the path to achieving the unit's goals?

Thanks to the new structure of laterally coupled cavity VCSELs, we have established an ultra-high-speed modulation that greatly expands the modulation bandwidth. We are pushing the limit of modulation bandwidth and low power consumption beyond existing semiconductor laser technologies. In addition, we aim to realize ultra-high-resolution beam deflection with giant angular dispersion in a VCSEL amplifier structure. We will support implementation of these advanced technologies through joint research with industry, government, and academia.

Massively parallel optical interconnect and laser radar using VCSELs



VCSEL array for ultra-parallel high-speed interconnects



Solid state high-resolution LiDAR

Q What impact will the unit's research have on society?

Our research is expected to lead to low power consumption, low cost, and high-density optical interconnects that enable ultra-high-speed data transmissions of 100Gbps to 1Tbps. It could contribute to the development of 6G mobile communication networks and power-saving in datacenter networks, which are the core infrastructure of our information society. The evolution of autonomous driving technology by high-resolution 3D sensing and virtual reality by 3D cameras on mobile phones will advance adoption of cyber-physical systems, sensing and digitizing the real world and projecting it into cyberspace. Through this research unit, we will expand the applications of VCSELs to various fields.

Contact us

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